A SURVEY OF METHODS NOW USED FOR BOLL WEEVIL CONTROL WITH COMMENTS ON CERTAIN METHODS

by

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During August and September 1935 a survey was made of cotton insect conditions in the eleven states where the boll weevil is a serious pest. The survey was made to obtain direct information as to the measures actually used by the growers to control the boll weevil, and to learn the results obtained from each of the various methods of control in the different sections of the extensive area where the boll weevil occurs. Special effort was made to obtain information on: (1) the value of the sweetened poison (molasses calcium arsenate mixture) and the extent to which it is used; (2) the value of dusting with calcium arsenate and the extent to which it is used; and (3) the extent and nature of injury to soils and crops following the use of calcium arsenate in boll weevil control.

STATES VISITED AND PEOPLE INTERVIEWED:

The eleven states visited include all of the states where the boll weevil causes serious loss — Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Arkansas, Louisiana, Texas, and Oklahoma. Several days were spent in each state except Virginia and Florida. Besides conferring with many cotton growers, from tenant farmers with a few acres to some of the largest planters in the country,

conferences were held with many state agricultural extension officials, including directors, cotton specialists, agronomists, entomologists, and district and county agents; the directors, entomologists, agronomists, plant pathologists, cotton breeders and other officials of the agricultural experiment stations; state entomologists and other officials connected with the state departments of agriculture; merchants, insecticide dealers; airplane dusting companies; and many others.

RESULTS OF SURVEY

NATURAL CONTROL:

Most cotton growers realize that temperature and rainfall during June and July are probably the greatest factors governing boll weevil abundance and damage. They also realize that the number of weevils entering hibernation depends largely upon weather conditions in the fall, the date of the first freeze, and the presence or absence of leaf worms in numbers large enough to defoliate the plants. They realize that winter temperatures largely determine the number of weevils that survive and emerge in the spring. Some growers in all states recognize the fact that the insect enemies of the boll weevil play a part in its natural control. In Georgia this was noted especially as several in that state reported personal observations along this line.

INDIRECT CONTROL MEASURES:

In all of the states the value of the indirect methods of weevil control is generally recognized. Most cotton growers appreciate the importance of thorough preparation of the soil; early

planting; the use of suitable varieties for each region; proper spacing, cultivation, and fertilization; early fall destruction of the cotton stalks; and the elimination or reduction of hibernation quarters. These practices have increased from year to year since the advent of the boll weevil in each region. Taken together they help greatly in reducing the boll weevil damage. These practices and a more general adoption of crop diversification and the introduction of new crops forced upon the cotton growers by the boll weevil have brought about a remarkable change in farming in the South. Some people even go so far as to call the boll weevil a "blessing in disguise".

DIRECT CONTROL MEASURES:

The direct control measures that are used enough to deserve special discussion in this report are: (1) dusting with calcium arsenate after 10 percent of the squares are infested; (2) presquare applications of molasses-calcium arsenate mixtures or of calcium arsenate dust; and (3) combinations of those two methods, i.e., presquare mopping with molasses mixtures or dusting with calcium arsenate followed by later dusting as needed. Other measures used by a few farmers scattered throughout the states include picking up infested squares, mopping or spraying throughout the season with various poisons including mixtures of white arsenic, dusting with lead arsenate, Paris green, and London purple and attaching brushes to cultivators to knock the weevils off the plants.

Taking the cotton belt as a whole, only a small percentage of the growers have used any of the direct control measures during the

past few years, although the total acreage poisoned is large and several million pounds of calcium arsenate are used annually. In all sections visited it was evident that direct control measures had been much more generally used during previous years. Many growers referred to their experiences with these control measures at various times usually from 6 to 15 years ago.

The chief reasons given by growers for not using direct control measures as much as formerly are: (1) the recent hot, dry summers have controlled the weevils; (2) the extremely low price of cotton a few years ago; (3) the use of indirect control measures have been sufficiently effective; and (4) in South Carolina the fear of soil injury from the use of calcium arsenate.

The amount of damage caused by the boll weevil and the direct control measures used in recent years varies greatly in different parts of the cotton belt which may be roughly divided into the western, central and eastern sections.

The Western Third -- In most parts of the western third of the area where the boll weevil occurs -- Texas and Oklahoma -- the scarcity of woods for hibernation quarters and the hot, dry summers usually prevent the weevil from becoming a serious pest and direct control measures are seldom necessary. When they are necessary, dusting with calcium arsenate is the usual method of control used.

The Central Third -- In the central part of the belt there are many large areas of dense woods. In general, humid conditions

prevail. It is here where the weevils cause the greatest damage and control measures are most extensively used. Many growers in this region wait until their fields are badly infested before dusting with calcium arsenate and then continue dusting at frequent intervals until the weevils are brought under control and a crop of bolls is set. Early season dusting of portions of fields where weevils are abundant or "spot" dusting is also a common practice. This is followed later when necessary by general field dusting with ground machines or airplanes. A large proportion of the total acreage dusted in the United States occurs in this region in East Texas and in the Delta Sections of Arkansas, Louisiana, and Mississippi. Several dozen airplanes operate in this area and annually dust many thousands of acres of cotton.

The Eastern Third -- The large areas of piney woods in the eastern third of the cotton belt are comparatively open and warm up rapidly in the spring. This with the early and mild season and the frequent spring rains probably account for the early emergence of weevils which in turn probably explains why the presquare poisoning has been found to be more effective and profitable in this region than elsewhere. On the average the cotton in this region seems to mature earlier possibly due to the planting of varieties with determinate growth and possibly also due to soil conditions. The boll weevil does not increase to such numbers and cause as much damage on this type of cotton as it does on cotton

that continues growing and fruiting until checked by frost.

For several years in this region the boll weevil has been held in check by hot, dry periods during the summers. Some dusting with calcium arsenate is done but presquare applications of sweetened poison or "mopping" is more extensively used than elsewhere, especially in South Carolina. Mopping is seldom used in the other sections.

South Carolina -- Although conditions in this state are similar to those in the other states in the eastern third of the cotton belt, there are some notable differences so far as the boll weevil problem is concerned. In this state we found the only cases of soil injury from the use of calcium arsenate in boll weevil control. This was the only state where cotton aphid damage following the use of calcium arsenate dust was mentioned by the growers and county agents before we made special inquiry about it. This was the only state (except Florida) where any serious objection was expressed to the use of calcium arsenate dust. It was the only state where the most of the county agents and growers thought that the presquare mopping of cotton was a more satisfactory control measure than dusting with calcium arsenate.

DISCUSSION OF METHODS

PRESQUARE APPLICATIONS OF MOLASSES-CALCIUM ARSENATE MIXTURES OR OF CALCIUM ARSENATE DUST:

The use of poison to kill the boll weevils surviving hibernation before squares are available for food and oviposition has always seemed an excellent method of control from a theoretical viewpoint. It has been tested under many conditions and this Department and many state agencies have for years recommended early season or presquare applications of either dust or sweetened poison as an auxiliary method when weevils are abundant, to be followed by later dusting when needed. Sometimes later dusting is not needed.

Sweetened poisons were tested against the boll weevil by some of the early workers in Texas before 1900 but they were not found to have much value. Since 1920 many experiments using sweetened poison alone or in combination with dusting have been conducted in different sections by this Department and the State Experiment Stations. The results of such tests in South Carolina and Oklahoma have been published in state bulletins. Some of the unpublished results of the Department will be summarized here. Most of the tests with sweetened poisons have been made with the 1-1-1 mixture, made by thoroughly mixing one pound of calcium arsenate in a gallon of water and then adding one gallon of molasses or table syrup. This mixture is usually applied to the tops of the small cotton plants by means of a homemade mop at the rate of one to two gallons per acre and is usually referred to as "mopping". In all of the Department's tests, plots of approximately one acre with comparable checks for each plot are used.

A summary of the tests at Tallulah are given in table I.

Although some increase in yield was obtained from presquare poisoning, much greater yields were obtained from the use of calcium arsenate dust. In a large series of tests at Florence, S. C., a summary of which is given in table 2, profitable results were obtained from presquare mopping but the control secured from dusting with calcium arsenate was much more satisfactory and the combination of these two methods gave still better results.

Cotton growers who recommend the exclusive use of sweetened poison for boll weevil control say the advantages this method has over the dusting method are its cheapness and practicability for the small farmer as no dusting machinery is required and because it does not cause heavy aphid infestations or injury to the soil. The opinion has been advanced that if the presquare poisoning were used by all growers in a large area, such as several adjoining counties or an entire state, the results would be satisfactory. Some of those interviewed expressed the belief that the universal use of the presquare mopping method of control over a large area will delay for a week or more the general movement of weevils during the late summer. Should this prove to be the case, its general adoption would be of great value to the cotton growers as at this time cotton is usually blooming heavily. If direct experimental evidence on the actual gain by the universal practice of presquare mopping were secured over a series of years, by a carefully planned large experiment with the cooperation of all the growers throughout the treated area covering several adjoining counties, definite conclusions could be drawn. South Carolina would be the best state for such an experiment as more people are acquainted with this method of control and better cooperation could be obtained from county agents

and many leading planters. It is difficult to secure dependable experimental results of boll weevil control and comparable yield records over large areas because of variations in weevil infestation, uniformity of soil, and other conditions. For these reasons most of the experimental work of the Department has been limited to one-acre plats as these areas are as large as can be found with uniform, comparable conditions. However considerable data on the seasonal square infestation in fields treated with molasses-calcium arsenate mixtures and untreated fields have been collected by the county agents and others in South Carolina. In one series of observations square infestation records were made by the county agent on treated and untreated cotton on 67 farms in Florence and Darlington Counties, South Carolina in 1929 with the following results:

Date	Early Poison (1-1-1)	Not Poisoned
June 17 to 21	1.9	17.2
June 24 to 29	4.3	19.2
July 1 to 6	3.1	17.9
July 8 to 13	4.3	15.2
July 15 to 20	4.5	22.1
July 22 to 27	8.2	32.0
July 29 to Aug. 3	23.5	54.1
Aug. 5 to 10	51.4	74.2

The yield records on these farms are not available and it is not known how much of the benefits of the reduction in square infestation is shown in the final yields.

DUSTING WITH CALCIUM ARSENATE AFTER 10 PERCENT OF THE SQUARES ARE INFESTED:

Dusting with calcium arsenate is the method most generally used and we found no one who had used it properly who questioned its efficacy as a boll weevil control. In the experiments conducted by this Department and the state experiment stations this method of control alone, or when preceded by presquare poisoning, has given the most profitable returns; especially has this been the case where heavy boll weevil infestations occur in cotton growing on fertile soils. Although when properly used calcium arsenate dust seems to practically always give satisfactory results, there are however, objections to its use. An increase in aphid abundance often follows the use of several applications of calcium arsenate dust. Aphids are nearly always present on cotton but are usually held in check by parasites and predators. These natural enemies are reduced by the use of arsenicals, and the aphids then increase in abundance. Heavy aphid infestations also occur at times when no arsenicals are used. There is considerable difference of opinion as to the amount of damage caused by aphids, most growers considered the increased abundance of aphids a small matter compared to the benefit derived from dusting. The best gains in yields and largest profits from dusting are always secured where the boll weevil infestation is heavy and several applications of dust are required for control. These are the conditions under which heavy aphid infestation is most likely to develop. Other objectionable features sometimes mentioned are that to make the necessary applications properly requires considerable outlay for dusting machines and poison and much night work.

South Carolina was the only state where any serious objection was expressed to the use of calcium arsenate because of the danger of causing injury to soils and crops following its use. It was also the only state in which any soil injury was found. There is some criticism of the recommendation of beginning the application of dust when 10 percent of the squares are infested. Some planters think it is not economical or practical to begin applying poison when only 10 percent of the squares are infested. They state that several times 10 percent of the squares will be shed under normal conditions if no weevils are present. They argue that no matter how numerous the weevils are at the beginning of the season, if the weather is hot and dry during the middle of the summer, the weevils will be held in check and the time and money used before then in applying poison is wasted. They may do some "spot" poisoning early in the season near woods or other badly infested "spots" but for the general application of poison they wait until the cotton is fruiting rapidly. Then, if the weevils are abundant and weather conditions are favorable for their increase, calcium arsenate dust applications are made at regular intervals until the weevils are checked and a crop of bolls is set. These planters pay little or no attention to the 10 percent recommendation; their decision as to when to begin poisoning depends as much upon the fruiting condition of the cotton and the weather conditions as upon the number of weevils that are present. They say it makes no difference whether there is a 10-percent or a 60-percent infestation; if the cotton is growing vigorously and fruiting rapidly they can check the weevils and make a normal crop. Other planters take an opposite view and claim poisoning should begin as soon as

weevils appear as it is very important to save the first bolls. Both groups of planters may be right so far as their particular conditions are concerned. The planters who wait until late in the season before beginning applications of dust are usually located on rich fertile soils where cotton continues to bloom until checked by frost while those who begin dusting early to save the first bolls are usually located on light soils where the cotton plants have a more determinate growth and mature early.

PRESQUARE POISONING FOLLOWED BY LATER DUSTING WITH CALCIUM ARSENATE AS NEEDED:

This is the method that has been generally recommended for the past ten years. The Cotton Council of the Association of Southern Agricultural Workers reviewed all the boll weevil control experiments conducted by the state experiment stations and this Department and made recommendations that were adopted by the Association in 1924 and were slightly modified and again adopted at Memphis, Tennessee in February 1928 as follows:

> "For the boll weevil, one presquare poisoning may be applied if it appears that there are numerous overwintered weevils present. This should be given just as squares begin to form. Then apply the regular series of three or more dust applications of calcium arsenate at four or five day intervals, beginning when an average of approximately one-tenth of the squares show weevil punctures. Dusting should be continued as needed to keep this infestation low until a full crop is set and matured beyond the probability of further weevil injury."

These recommendations were designed to cover the entire area where the boll weevil occurs. Tests in South Carolina show that presquare poisoning followed by dusting when needed gave the most profitable yields. In similar tests in Louisiana nothing was gained by the presquare mopping and in Oklahoma the gains were very slight. Some growers consider

the presquare application of poison as a sort of insurance. It costs little and there is always the hope that enough weevils will be killed to justify the cost of treatment. Some think it is a mistake to advise any presquare poisoning because many of those who use this method will not follow it up with later dustings. It gives them a feeling of security that is often not justified and if the boll weevils later cause serious damage they lose confidence in all control measures.

SOIL INJURY FROM THE USE OF CALCIUM ARSENATE:

Of the cases of soil injury reported all were confined to the sandy soils of South Carolina and seem to be correlated with deficiencies of iron and manganese. While all cases which came to our attention were where there was used larger quantities of calcium arsenate over a period of years than are recommended for weevil control, there is no evidence that the use of the recommended amount might not also cause soil injury. The injury from arsenic is manifested by poor stands of cotton and more particularly by the effect on growth of oats and legumes which are extensively planted in that section. Soil injury from arsenic is a serious local problem but so far as is now known is confined to a small section of the cotton belt. In that section, however, some workers expressed the opinion there is a tendency to attribute to calcium arsenate crop failures due to other causes. Investigations are in progress to determine the danger of soil injury to other sections of the cotton belt.

TABLE I.

Summary of Molasses-Calcium Arsenate Mixture and Calcium Arsenate Dust Experiments for Boll Weevil Control at Tallulah, La. 1921-1929

Treatment	No. of Tests	Av. Yield Lbs. Seed Cotton per A.	Increased yield Treated over checks lbs.	%	Ave. No. of Effective Applications
Molasses-cal. ars. mixture (mopping started before squaring and continued at 4 and 7 day intervals)	16	989	54	5.7	7.4
Cal. ars. Dusting	14	1162	227	24.2	5.6
Mol. cal. ars. mixture (1 to 6 moppings beginning in presquare stage)	33	1360	32	2.4	
Mol. cal. ars. Mixt. (2 presquare moppings followed by spraying)	5	854	149	21.0	6.5
Cal. ars. dusting (applied on same date as above molasses mixture)	5	922	215	30.4	6.5
Molasses-cal. ars. mixt. (3 early moppings)	7	1285	28	2.2	3 moppings
1 presquare mopping followed by cal. ars. dusting after 10% infestation	14	1562	219	16.3	1 mopping 5.3 dustings
Cal. ars. dusting after 10% infestation	7	1669	240	16.8	5.7 dustings

TABLE II.

Summary of Molasses-Calcium Arsenate Mixture and Calcium Arsenate Dust Experiments for Boll Weevil Control at Florence, S. C. 1928-1934

Treatment	No. of tests	Av. Yield lbs. seed cotton per acre	Increase of treated over check Lbs.	Increase of treated over check %	Av. no. appl.	Cost of treatment Per acre	Cost of treatment Per 100 lbs. gain	Profit per acre in $
Molasses mixture Early appls.	45	1016	49	5.0	3.2	1.29	2.63	2.28
Molasses mixture Early appls. followed by cal.ars. dust at 10% inf.	45	1153	325	39.2	2.5m. 5.5d.	4.26	1.31	11.76
Cals.ars. dusting after 10% infs.	44	1148	259	29.0	6.1d	3.42	1.32	8.03

m - mopping
d - dusting